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Reconciling Trends in Equatorial Pacific SST: Implications for ENSO Mechanisms

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Abstract: Understanding the response of the El Niño/Southern Oscillation (ENSO) system to external climate forcing is a critical challenge for 21st-century climate prediction. Modeling and theoretical studies can be used in support of either a transition to a more El Niño-like base state or its opposite, a more La Niña-like base state. One approach to reconciling these discrepancies is to examine the instrumental record of sea surface temperature (SST) variability in the tropical Pacific. However, observations are scarce to nonexistent in critical regions in before the mid-20th century, and SST products that span the past century depend on statistical infilling methods to create gridded fields. Trends across the 20th century derived from different SST products leadt o opposing conclusions on how the base state of the Pacific has changed.

We propose to use an existing collection of coral cores to address this discrepancy, by generating replicated records of SST from three equatorial Pacific sites using Sr/Ca. This work is collaborative with Dr. Sandy Tudhope (University of Edinburgh) who will work with the PI on the analysis of samples and on interpretation and publication of results. These cores span 110-150 year intervals beginning in the mid-late 19th century and ending in the last decade of the20th century. Five of the six have been fully analyzed for oxygen isotopes, which yields a mixed SST-salinity signal. Trends in these records are larger than one would expect (1-2.5°C), leading us to conclude that salinity and potentially other factors are obscuring true temperature changes. Sr/Ca appears to act as a temperature tracer uncontaminated by salinity artifacts, and preliminary measurements suggest much smaller trends.

We will examine cores from northern New Guinea (Laing and Madang Islands), Kiribati/Gilbert Islands (Maiana and Onotoa Atolls)and Jarvis Island. Instrumental records from these sites mimic the discrepancies identified in more complete analyses of the instrumental SST fields and we have confidence that SST reconstructions from these sites are therefore suitable for resolving the critical differences among existing instrumental SST datasets. The development of replicated records from each region also contributes to reducing the uncertainties associated with single core interpretations.

By combining Sr/Ca and $\delta^{18}O$ records from these corals, we will also determine to what degree we can isolate coherent patterns of low-frequency and secular variability in seawater $\delta^{18}O$ (~salinity). We will test the idea that low-frequency coral $\delta^{18}O$ variance coherent across large distances reflects processes that change surface seawater salinity, such as advection of water masses with varying salinities and the migration of atmospheric convergence (precipitation) zones. And we will be able to characterize the relative contributions of SST and seawater isotopic changes to interannual-decadal variations associated with ENSO indices. Replication of these records will enhance signal/noise and minimize nonclimatic sources of bias.